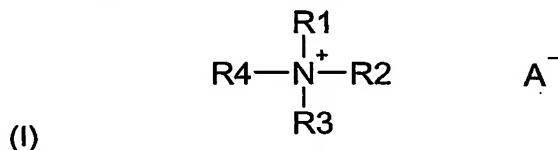


AGROCHEMICAL COMPOSITIONS

The present invention relates to agrochemical compositions and in particular to an aqueous composition comprising an agrochemical active ingredient and an
5 adjuvant.

Agrochemical active ingredients are generally utilized in combination with an adjuvant, which is frequently a surfactant. Most commonly adjuvants are added to enhance the bioperformance of the active ingredient and many such bioperformance enhancing adjuvants are known to those skilled in the art. We have now found that
10 certain amines and amine salts, or short-chain alkyl quaternary ammonium salts provide effective bioperformance enhancement of the active ingredient despite having little or no surfactant properties.

According to the present invention there is provided an agrochemical composition comprising an agrochemical active ingredient and an amine or amine
15 salt or short-chain alkyl quaternary ammonium salt adjuvant. The adjuvants of the present invention are preferably an amine salt or a short-chain alkyl quaternary ammonium salt having the structure of formula (I):



wherein R^1 , R^2 , R^3 and R^4 (which may be the same or different) are C_2 to C_4 alkyl
20 or R^1 is hydrogen and R_2 , R_3 and R_4 (which may be the same or different) are C_2 to C_4 alkyl,

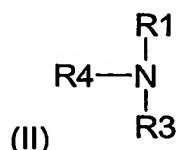
or R^1 and R^2 are hydrogen and R^3 and R^4 (which may be the same or different) are C_2 to C_4 alkyl,

or R^1 and R^2 and R^3 are hydrogen and R^4 is $\text{C}_2\text{H}_5\text{OH}$,

25 or R^1 is hydrogen and R^2 , R^3 and R^4 is $\text{C}_2\text{H}_5\text{OH}$,
provided that R^1 , R^2 , R^3 and R^4 are not all ethyl and that when R^1 is hydrogen R_2 , R_3 and R_4 are not all ethyl,

and A^- is an agrochemically acceptable anion;

or an amine having the structure of formula (II):

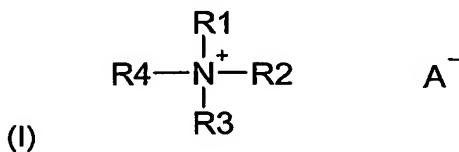


30 wherein R^1 , R^2 and R^3 (which may be the same or different) are C_2 to C_4 alkyl.,

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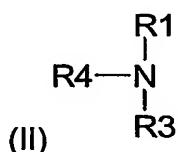
wherein R¹ is hydrogen R², R³ (which may be the same or different) are C₂ to C₄ alkyl or R¹, R² are hydrogen and R³ is C₂H₅OH, or R¹, R², and R³ is C₂H₅OH, provided that R₁, R₂ and R³ are not all ethyl.

5 According to a further aspect of the present invention there is provided a method of improving the activity of an agrochemical active ingredient which comprises incorporating therein an amine salt thereof having the structure of formula (1) or a short-chain alkyl quaternary ammonium salt having the structure formula (I):



10 wherein R¹, R², R³ and R⁴ (which may be the same or different) are C₂ to C₄ alkyl, or R¹ is hydrogen and R₂, R₃ and R₄ (which may be the same or different) are C₂ to C₄ alkyl, or R¹ and R² are hydrogen and R³ and R⁴ (which may be the same or different) are C₂ to C₄ alkyl, or R¹ and R² and R³ are hydrogen and R⁴ is C₂H₅OH or R¹ is hydrogen and R², R³ and R⁴ is C₂H₅OH provided that R¹, R², R³ and R⁴ are not all ethyl and that when R¹ is hydrogen R₂, R₃ and R₄ are not all ethyl; and A⁻ is an agrochemically acceptable anion;

15 or an amine having the structure of formula (II):



wherein R¹, R² and R³ (which may be the same or different) are C₂ to C₄ alkyl, wherein R¹ is hydrogen R², R³ (which may be the same or different) are C₂ to C₄ alkyl or R¹, R² are hydrogen and R³ is C₂H₅OH, or R¹, R², and R³ is C₂H₅OH, provided that R₁, R₂ and R³ are not all ethyl.

As specific amines or amine salts suitable for use in the present invention there may be mentioned diethylamine or a salt thereof; ethanolamine or a salt thereof, and triethanolamine or a salt thereof. As specific short-chain alkyl quaternary ammonium salts suitable for use in the present invention there may be

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mentioned a tetrapropylammonium salt and a tetrabutylammonium salt. It is preferred however that the amine of the present invention is not a triethylamine salt and that the quaternary ammonium salt is not a tetraethylammonium salt.

The amines of the present invention are basic compounds and if used in their basic form may be incompatible with base-sensitive agrochemicals (such as paraquat), or base sensitive formulants (such as some alcohol ethoxylate surfactants); as well as being a potential hazard to human exposure. It is preferred therefore that in normal use and in particular when used with base-sensitive agrochemicals and/or formulants, the amines of the present invention are neutralized in whole or part. The amines of the present invention may conveniently be neutralized by the addition of acid, for example a mineral acid such as a halide acid, for example hydrochloric acid, or an organic acid such as acetic acid. The amines of the present invention may also however be neutralized by the addition of any suitable anionic acid species, including anionic surfactants.

The term "a salt of the amines of the present invention" as used herein includes the amines of the present invention whether wholly or partially neutralized by an anionic species and does not necessarily imply the physical association of the amine cation and the anionic species in the composition. It will generally be convenient to neutralize or partially neutralize the amines of the present invention prior to incorporation in the composition of the invention.

The term "agrochemical active ingredient" as used herein includes without limitation herbicides, insecticides, fungicides, plant growth regulators and seed treatment agents. It is preferred that the agrochemical compositions are aqueous compositions and it is especially preferred that the agrochemical active ingredient is a water-soluble agrochemical active. The aqueous agrochemical compositions may generally be applied to the target by spraying and the composition may be a concentrate which is designed to be diluted with water prior to application or may be ready for application. Specifically, the amines of the present invention, or a salt of the amine or short-chain alkyl quaternary ammonium salts, may be incorporated into the spray composition prior to application as a tank mix or may form a component of an agrochemical concentrate intended for dilution prior to use. It is a particular advantage of the salts of amines or quaternary ammonium salts, of the present invention that they are readily soluble in water and are generally compatible with water-soluble agrochemicals. Salts of amines or short-chain alkyl quaternary ammonium salts, of the present invention are thus particularly suitable to be "built-in" to a concentrate comprising a water-soluble active ingredient.

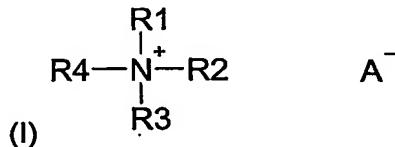
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Suitable agrochemical active ingredients are known to those skilled in the art and are listed in standard reference books such as the Pesticide Manual. As examples of suitable water-soluble active ingredients there may be mentioned paraquat, diquat, glyphosate, fomesafen, thiamethoxam, mesotrione, trifloxsulfuron 5 or mixtures thereof. By the term "water-soluble" agrochemical is meant an agrochemical having a solubility in water of at least 1 g/l and preferably at least 4 g/l, for example at least 100 g/l. Of course many agrochemicals have a much higher solubility, for example 300 g/l or more or up to 500 or 600 g/l or more. Paraquat and diquat and mixtures thereof are particularly suitable water soluble agrochemical 10 active ingredients.

Although the following description will focus on the preferred water soluble agrochemical actives, it is to be understood that other water soluble agrochemical actives may be used in the present invention.

Preferably, aqueous compositions according to the invention contain at least 15 40 grams per litre of paraquat or diquat or mixtures thereof (individually or in combination referred to herein as bipyridylum salt) expressed as bipyridylum ion. The compositions may contain greater than 50 grams per litre, for example greater than 100 grams per litre of bipyridylum ion. Compositions containing 200 grams or more per litre, may be prepared although a concentration of paraquat in excess of 20 about 250 or 300 g/l tends to be unstable. In general compositions do not contain greater than 400 grams per litre of bipyridylum ion.

Thus according to a further aspect of the present invention there is disclosed an aqueous agrochemical composition comprising paraquat or diquat or a mixture thereof; and an adjuvant selected from an amine or a salt thereof having the structure 25 of formula (1) or a short-chain alkyl quaternary ammonium salt having the structure of formula (1):



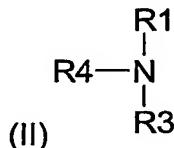
wherein R^1 , R^2 , R^3 and R^4 (which may be the same or different) are C_2 to C_4 alkyl, or R^1 is hydrogen and R_2 , R_3 and R_4 (which may be the same or different) are C_2 to 30 C_4 alkyl, or R^1 and R^2 are hydrogen and R^3 and R^4 (which may be the same or different) are C_2 to C_4 alkyl, or R^1 and R^2 and R^3 are hydrogen and R^4 is $\text{C}_2\text{H}_5\text{OH}$ or R^1 is hydrogen and R^2 , R^3 and R^4 is $\text{C}_2\text{H}_5\text{OH}$

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provided that R¹, R², R³ and R⁴ are not all ethyl and that when R¹ is hydrogen R₂, R₃ and R₄ are not all ethyl,

and A⁻ is an agrochemically acceptable anion;

or an amine having the structure of formula (II):



5

wherein R¹, R² and R³ (which may be the same or different) are C₂ to C₄ alkyl,

wherein R¹ is hydrogen R², R³ (which may be the same or different) are C₂ to C₄ alkyl,

or R¹, R² are hydrogen and R³ is C₂H₅OH,

or R¹, R², and R³ is C₂H₅OH,

10 provided that R¹, R² and R³ are not all ethyl.

Suitable agrochemically acceptable anions include for example, the anion from an inorganic or organic acid, for example the halide ion from a halide acid; or for example, the chloride ion from hydrochloric acid.

According to a still further aspect of the present invention there is disclosed

15 an aqueous agrochemical composition comprising paraquat or diquat and diethylamine or a salt thereof, ethanolamine or a salt thereof, triethanolamine or a salt thereof, a tetrapropylammonium salt or a tetrabutylammonium salt, wherein the concentration of the paraquat or diquat is greater than 100 g/l.

Typically the pH of the paraquat or diquat composition of the invention will be 20 from 3.0 to 8.0 and preferably from 4.0 to 8.0. In general the pH of the amine is adjusted with acid approximately to that of the paraquat or diquat composition and those nitrogen atoms of the amine which are sufficiently basic become protonated.

While the scope of the present invention is not limited to any particular bipyridyl composition, the invention is particularly suitable for use with an aqueous 25 formulation of a bipyridylum herbicide such as those described in WO 02/076212 A1. In WO 02/076212 there are described the use of an alginate as a pH-triggered gelling agent in the manufacture of a herbicide composition comprising a salt of paraquat, a salt of diquat or a mixture thereof. The composition further comprises an emetic and/or purgative such that a pH-triggered gel effect takes place at the acid pH of 30 human gastric juice compositions. It is generally desirable to include one or more surfactants or adjuvants in such compositions to improve the bioperformance of the herbicide. A number of possible adjuvants are listed in WO 02/076212.

Furthermore, the composition also preferably contains a purgative such as

magnesium sulphate. We have now found that physical compatibility issues may arise with many of the adjuvants listed in WO 02/076212. Such compatibility issues are exacerbated at relatively high concentration of bipyridylum ion (for example greater than 100 g/l and in particular if the concentration reaches about 200 g/l or 5 more). Furthermore, the presence of relatively high concentrations of the purgative electrolyte magnesium sulphate recommended in WO 02/076212 further increases potential compatibility difficulties. Thus WO 02/076212 recommends that when the composition of the invention contains a purgative, preferably magnesium sulphate, the concentration of magnesium sulphate is preferably from 10 to 400 grams per litre 10 of the composition, and more preferably from 10 to 100 grams per litre. Higher concentrations of magnesium sulphate, for example up to 400 grams per litre, may be used and may continue to provide increased purgative effect but such high levels of magnesium sulphate may have an adverse effect on formulation stability. As noted above, we have found that in practice formulation stability may also be 15 compromised at concentrations below 400 g/l, for example around 100 g/l.

It is to be understood that the term physical incompatibility in relation to adjuvants used in bipyridyl compositions indicates either gross separation of one or more components of the composition which may or may not be accompanied by a significant change in formulation rheology or bulk homogeneity. It is not necessarily 20 essential that the composition is fully homogeneous in a strict physical sense provided that the composition is substantially homogeneous in the bulk. Thus a slight separation of a second phase may be acceptable provided that the separated phase remains fully dispersed in the bulk. If however any separated phase is not fully dispersed in the bulk, but for example rises to the surface of the composition, the 25 composition may not show bulk homogeneity and a sample taken from one portion of the bulk may have a different composition from a sample taken from a different portion of the bulk. This is obviously undesirable for a number of reasons. The term physical compatibility indicates the reverse of physical incompatibility as defined above.

30 We have found for example that compositions of WO 02/076212 containing about 120 g/l paraquat ion and about 80 g/l diquat ion in the presence of an alginate and about 120 g/l of magnesium sulphate heptahydrate may show physical incompatibility, when it is attempted to incorporate many of the adjuvants listed therein. Thus physical separation was observed when tallow amine ethoxylate was 35 incorporated at levels above about 1.0 g/l. Two phases were formed when it was attempted to incorporate a sodium salt of dodecyl benzene sulphonate at levels

above about 10 g/l. Two phases were also formed when it was attempted to incorporate sodium dioctyl sulfosuccinate even at concentrations below 10 g/l. Some physical separation was observed when it was attempted to incorporate an alkyl ethoxy carboxylate at a level of 50 g/l and it is believed that the adjuvant would be 5 unacceptable even at lower levels than this. Very poor compatibility was observed with certain alcohol ethoxylates, even at concentrations below 10 g/l. While it may be possible to overcome or mitigate such compatibility issues by reducing the concentrations of one or more of the components or by careful blending of adjuvants, all at reduced concentrations, there is a need for an adjuvant that is compatible in the 10 compositions described in WO 02/076212, at relatively high loadings and yet exhibits a good bioperformance enhancement which is equivalent to or not much reduced from conventional adjuvants which exhibit potential incompatibility.

We have found that the amines, or salts thereof, or short-chain alkyl quaternary ammonium salts of the present invention when used as adjuvants meet 15 this need. Thus for example, tetrapropylammonium bromide and tetrabutylammonium bromide are compatible (with no significant gross separation) at a loading of 50g/l of the short-chain alkyl quaternary ammonium salt with compositions of WO 02/076212 (containing about 200 g/l paraquat ion in the presence of an alginate and about 120 g/l of magnesium sulphate heptahydrate). 20 Thus for example, diethylamine (as a hydrochloride salt) and ethanolamine (as a hydrochloride salt), are compatible at a loading of 50g/l actual amine (with no significant gross separation) with compositions of WO 02/076212 (containing about 200 g/l paraquat ion in the presence of an alginate and about 120 g/l of magnesium sulphate heptahydrate).

25 According to a still further aspect of the present invention there is provided an aqueous agrochemical composition comprising paraquat or diquat and diethylamine or a salt thereof, ethanolamine or a salt thereof, triethanolamine or a salt thereof, or a tetrapropylammonium salt or a tetrabutylammonium salt, wherein the concentration of the paraquat or diquat is greater than 100 g/l and which further contains from 10 to 30 400 grams per litre, for example from 10 to 100 grams per litre of an electrolyte purgative such as magnesium sulphate.

According to a still further aspect of the present invention there is provided an aqueous agrochemical composition comprising paraquat or diquat and diethylamine or a salt thereof, or ethanolamine or a salt thereof, or triethanolamine or a salt 35 thereof, or a tetrapropylammonium salt or a tetrabutylammonium salt, wherein the

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concentration of the paraquat or diquat is greater than 100 g/l and which further comprises an alginate which is a pH-triggered gelling agent, such that a pH-triggered gel effect takes place at the acid pH of human gastric juice, together with from 10 to 400 grams per litre, for example from 10 to 100 grams per litre, of an electrolyte

5 purgative, such as magnesium sulphate.

The amines or a salt thereof or short-chain alkyl quaternary ammonium salts of the present invention when used as sole adjuvant may provide effective bioperformance enhancement. However, there may be advantages in using the amines or a salt thereof or short-chain alkyl quaternary ammonium salts of the

10 present invention in combination with a second adjuvant. The second adjuvant is preferably a surfactant. There is no particular limitation on the surfactant that may be used and numerous examples will occur to those skilled in the art. We have found that anionic, cationic, nonionic, amphoteric or Zwitterionic surfactants may be effective.

15 It is of course desirable that the second adjuvant also exhibits acceptable compatibility, for example with compositions such as those described in WO 02/076212, although the second adjuvant may well be present at a lower concentration than that of the amine or a salt thereof or short-chain alkyl quaternary ammonium salt adjuvant of the present invention, so that this aspect may not be as crucial. As examples of suitable second adjuvants there may be mentioned alkyl polyglycosides, betaines, alkylethoxy phosphates and salts thereof, alcohol ether carboxylic acids and salts thereof, alcohol ether sulphates and salts thereof. As examples of second adjuvants that may exhibit physical incompatibility at higher concentrations but may still be acceptable if incorporated at relatively lower levels 20 compared with the amine adjuvant, there may be mentioned alcohol ethoxylates, amine ethoxylates, amine oxides and cationic surfactants.

25 As examples of suitable alkylpolyglycosides (APG's) there may be mentioned for example C₈₋₁₀ alkyl polyglycosides with a degree of polymerisation of 1.5-2.0 (commercially available examples include AQNIQUE 8107-U). As examples of amine ethoxylates there may be mentioned for example C₁₂₋₁₈ alkyl amine ethoxylates (5-50 moles). Commercially available examples include SYNPROLAM 30 35X15, ETHOMEEN C25 or T25. As examples of cationic surfactants and ethoxylated quaternary ammonium salts include C₈₋₁₈ alkyltrialkyl ammonium halides (commercially available examples include ARQUAD 16-50). As examples of amine 35 oxides include C₁₂₋₁₈ saturated or unsaturated alkyl- dimethyl amine oxides (commercially available examples include AROMOX MCD-W). As examples of

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betaines include for example alkyldimethyl betaines and alkylamidopropyl betaines, where alkyl chain length can be C₁₂₋₁₈ (commercially available examples include TEGOBETAINE F50). As examples of alkylethoxyphosphates include for example C₄₋₁₈ alkylethoxy (2-10 moles) mono-,di- or sesqui- phosphate esters (as acid, inorganic or organic salts). Commercially available examples include CRODAFOS T5A, N10A and GERONOL CF/AR. As examples of alcohol ether carboxylates include for example those of C₈₋₁₈ alcohol ethoxylate (2-15 moles) carboxylates (as acid, inorganic or organic salts). Commercially available examples include EMPICOL CBF, CBJ, and CED-5. As examples of alcohol ether sulphates include for example C₈₋₁₈ alcohol ethoxylate (2-10 moles) sulphates (as acid, inorganic or organic salts). Commercially available examples include EMPICOL EAC70, EGC70, and ESC70.

As noted above the amines of the present invention may form a salt with an anionic surfactant or a surfactant having an acidic form. If desired, such a salt may be pre-formed by the reaction of the amines of the present invention with the anionic surfactant, for example in aqueous solution, but there is no particular need for such pre-reaction.

The ratio by weight of the amines or a salt thereof or short-chain alkyl quaternary ammonium salts of the present invention to the second adjuvant or co-adjuvant may vary within wide limits, for example from 50:1 to 1:50, and in particular from 10:1 to 1:10 by weight.

The ratio by weight of the amines or a salt thereof or short-chain alkyl quaternary ammonium salts of the present invention to the agrochemical active ingredient is preferably from 1:20 to 10:1, for example from 1:10 to 1:2. When the amines or a salt thereof or short-chain alkyl quaternary ammonium salts of the present invention are used in combination with one or more additional adjuvants, for example additional surfactants, the ratio by weight of the total adjuvant (amines or a salt thereof or short-chain alkyl quaternary ammonium salts of the present invention plus additional surfactants) is preferably from 1:10 to 10:1, for example from 1:5 to 10:1. The composition may contain further additives conventional in the art.

The invention is illustrated by the following Examples in which all parts and percentages are by weight unless otherwise stated.

EXAMPLE 1

The bioperformance enhancement of paraquat in the presence of amines or a salt thereof or short-chain alkyl quaternary ammonium salts of the present invention was evaluated. The amines or salts thereof or short-chain alkyl quaternary

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ammonium salts were tested and the results are presented in Table 1. An aqueous formulation of paraquat dichloride containing 0.5% by weight of the amine (based on the weight of the short-chain alkyl quaternary ammonium salt or the parent amine and based on total spray volume) was applied using a moving track sprayer to eight representative weed species at 10, 20 and 40 g /ha (based on paraquat ion). The spray volume was equivalent to 200 l/ha. Three replicates of each test were undertaken and the biological data (% activity where 0% represents no herbicidal effect and 100% represents complete kill) at 7 days after treatment is expressed in Table 1 as a mean over all species based on an average response over the combined rates. The results are compared with an equivalent formulation containing only paraquat chloride.

Table 1

Amine of the Present Invention	Mean Activity (%)
None	54
Diethylamine as the hydrochloride salt	66
Tetrapropylammonium hydrobromide	67
Tetrabutylammonium hydrobromide	72

EXAMPLE 2

An aqueous formulation of paraquat dichloride containing 0.5% by weight of the amine (based on the weight of the parent amine and based on total spray volume) was applied using a moving track sprayer to five representative weed species at 10 and 30 g active ingredient /ha (based on paraquat ion). The spray volume was equivalent to 200 l/ha. Four replicates of each test were undertaken and the biological data (% activity where 0% represents no herbicidal effect and 100% represents complete kill) at 6 days after treatment is expressed in Table 2 as a mean over all species based on an average response over the combined rates. The results are compared with an equivalent formulation containing only paraquat dichloride, and a paraquat dichloride formulation containing preferred surfactant adjuvants (at 0.2% by weight adjuvant based on total spray volume)

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Table 2

Amine of the Present Invention	Mean Activity (%)
None	42
A 'Standard' surfactant adjuvant	52
Ethanolamine (as a hydrochloride salt)	59
Triethanolamine (as a hydrochloride salt)	55